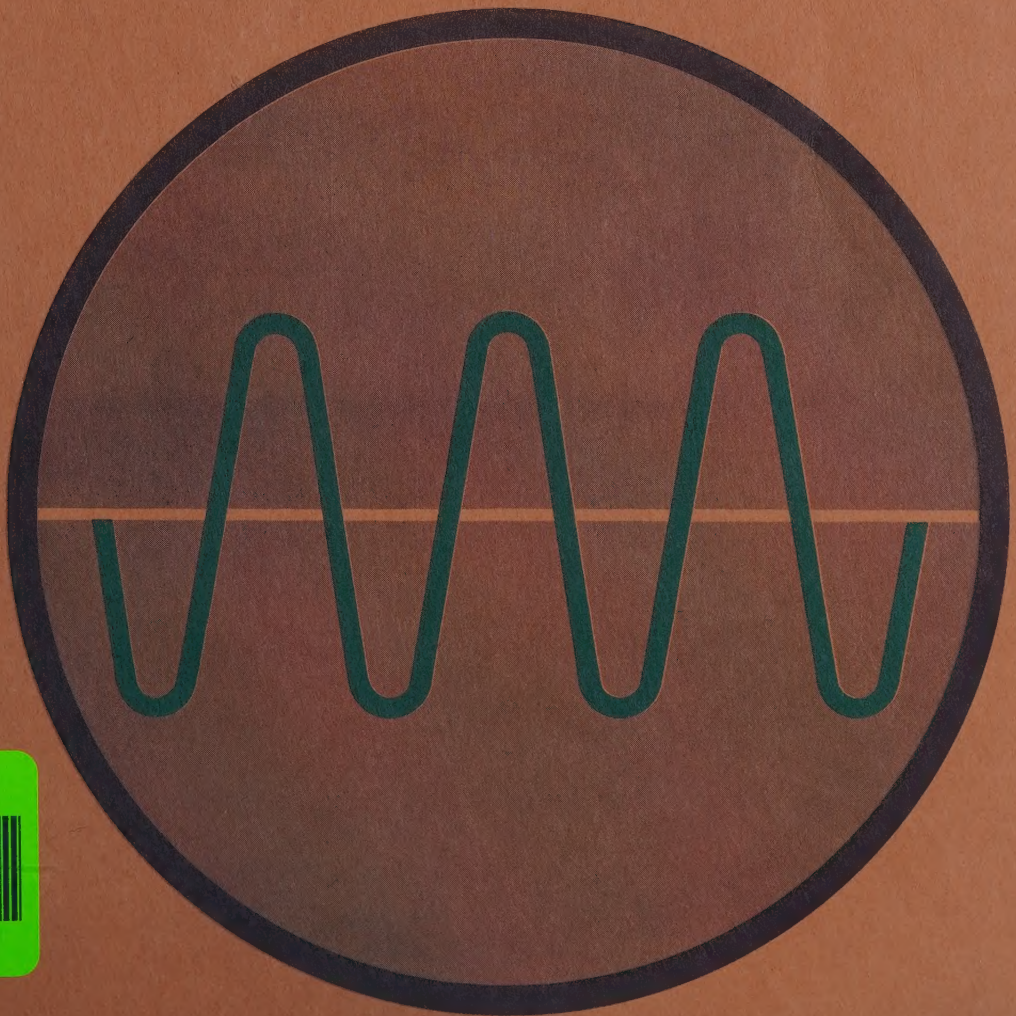
GTE-ERS
TECHNICAL LIBRARY
03425



**MOTOROLA** test equipment

# general purpose oscilloscope

**model T 1015A**



MP MASTER
MA36352

PRINTED IN U.S.A.

68P81004A90-O

# MOTOROLA

# GENERAL PURPOSE OSCILLOSCOPE

MODEL T1015A

AEPD-6626-O(MC6863)

**MOTOROLA INC.** COMMUNICATIONS DIVISION

*Engineering Publications* *4501 W. Augusta Blvd.* *Chicago 51, Illinois*

Copyright 1961 by Motorola, Inc.
Printed in U. S. A.

8/14/61-UM

68P81004A90
Issue - O

## GUARANTEED PERFORMANCE SPECIFICATIONS

GENERAL

| | |
|---|---|
| MODEL | T1015A General Purpose Oscilloscope |
| CATHODE RAY TUBE | Type 3RP1, medium persistence, green trace |
| POWER SUPPLIES | Transformer operated, fused. The B+ supply uses a 6X4 tube as a full-wave rectifier. The high voltage supply uses a 1V2 tube and the bias supply uses a silicon rectifier in half-wave circuits. Critical voltages are regulated with voltage regulator tubes. |
| INPUT CONNECTIONS | Vertical and horizontal inputs are 5-way binding posts, with 3/4" spacing. External synchronization and external capacity are also 5-way binding posts located on the front panel. |
| NET WEIGHT | 12-1/2 lbs |
| SHIPPING WEIGHT | 14 lbs |
| DIMENSIONS | 8-5/8" high x 4-5/8" wide x 12-3/4" deep overall |

VERTICAL AND HORIZONTAL CHANNELS (IDENTICAL)

| | |
|---|---|
| BANDWIDTH | dc to 200 kc (2 db point) |
| SENSITIVITY | .1 v (peak-to-peak) per 1/4" (uncalibrated) |
| ATTENUATOR | 3-position, compensated type |
| GAIN CONTROL | continuously variable |
| INPUT IMPEDANCE | 3.6 megohms shunted by 35 uuf |
| COUPLING | either a-c or d-c, selected with the input attenuator switch |
| CENTERING | Any portion of a 2" x 2" trace may be positioned on any portion of the cathode ray tube screen. |
| POLARITY | A positive signal applied to the vertical channel will deflect the beam up. A positive signal applied to the horizontal channel will deflect the beam to the left. |
| RELATIVE PHASE SHIFT BETWEEN CHANNELS | less than 5 degrees |

SWEEP GENERATOR

| | |
|---|---|
| RECURRENT TYPE | Linear saw-tooth produced by multivibrator type generator |
| SYNC PROVISIONS | Either internal or external synchronization may be switch-selected. The synchronization level is automatically maintained over a range of 1/4" to 2" vertical trace height. |
| FREQUENCY COVERAGE | From 5 cps to 50 kc in four overlapping ranges. Lower sweep rates may be obtained by adding capacity to the external capacity binding post on the front panel. |
| BLANKING | The retrace (or flyback) cycle is blanked with the internal sweep generator. |

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

# FOREWORD

## CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within forty-eight hours after receipt, if possible, or during a period not to exceed fifteen days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

## REPAIR AND/OR RECALIBRATION

It is suggested that the instrument be returned to:

Motorola Communications &
Electronics, Inc.
Parts and Service Department
4910 West Flournoy Street
Chicago 44, Illinois

for repair and/or recalibration. Before shipping the instrument notify the Parts and Service Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

## SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and then packed in a strong exterior container. It should be shipped via Truck, Railway Express, Air Freight, or Air Express.

# WARRANTY

Motorola instrument equipment other than tubes, fuses, vibrators, and batteries is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory Service Department for that purpose and to replace any defective parts thereof.

Tubes carry their own standard manufacturer's warranty of 90 days or 1000 hours, whichever first occurs.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

   Motorola Communication & Electronics, Inc.
   Parts & Service Department
   4910 West Flournoy Street
   Chicago 44, Illinois

   Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the above address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

# CONTENTS


| SECTION | PAGE |
|---|---|
| INTRODUCTION | 1 |
| DESCRIPTION | 1 |
| a. Front Panel Controls | 1 |
| b. Front Panel Receptacles | 1 |
| CIRCUIT DESCRIPTION | 2 |
| a. Amplifier Circuit | 2 |
| b. Sweep Generator | 2 |
| c. Power Supplies | 3 |
| PRE-OPERATIONAL ADJUSTMENTS | 3 |
| a. Preliminary Adjustments | 3 |
| b. Astigmatism Control | 3 |
| c. Vertical DC Balance | 3 |
| d. Horizontal DC Balance | 3 |
| e. Sweep Positioning Control | 3 |
| OPERATION | 4 |
| a. General Considerations | 4 |
| b. Vertical and Horizontal Amplifiers | 4 |
| c. Sweep Generator | 4 |
| d. Fine Frequency Control | 4 |
| APPLICATIONS | 4 |
| MAINTENANCE | 4 |
| a. Service Accessibility | 5 |
| b. Cathode Ray Tube Positioning | 5 |
| c. Horizontal Attenuator Compensation | 5 |
| d. Vertical Attenuator Compensation | 6 |
| e. Troubleshooting Chart | 6 |
| SCHEMATIC DIAGRAM | 7 |

## 1. INTRODUCTION

The Model T1015A Oscilloscope is a small compact instrument containing identical d-c coupled vertical and horizontal amplifiers. This coupling enables the oscilloscope to be used in the measurement of extremely low frequency phenomena. The small physical size of the unit provides easy portability and alleviates workshop congestion. The negligible phase shift between vertical and horizontal amplifiers makes the unit ideal for such specialized uses as computer readout.

## 2. DESCRIPTION

The louvered housing maintains continuous air circulation through the oscilloscope. An easel device on the bottom of the housing permits raising the screen to eye level. A tripod attached to the rear of the housing can be used for winding the a-c power cord when the unit is not in use. The "feet" of this tripod enable the unit to rest in the vertical position with the screen and controls facing upwards. The screen is calibrated in 5, 10 and 15 kc squares for use with an FM Station Monitor. A red pilot lamp glows when the oscilloscope is turned on.

a. Front Panel Controls

The controls on the front panel and their functions are as follows:

(1) VERTICAL Gain

This control regulates the gain of the vertical amplifier stage. The black knob, the VERTICAL attenuator, selects the voltage multiplier and either a-c or d-c coupling. The red knob which is continuously variable adjusts the heighth of the trace.

(2) HORIZONTAL Gain

This control regulates the gain of the horizontal amplifier stage. The black knob, the HORIZONTAL attenuator, selects the voltage multiplier and either a-c or d-c coupling. The red knob which is continuously variable adjusts the width of the trace.

(3) Sweep FREQUENCY

This control selects the HORizontal INput and the sweep FREQUENCY. The black knob selects either an external HORizontal INput, an EXTernal SYNChronization, or the internal sweep range with INTernal SYNChronization. The red knob which is the vernier FREQUENCY control adjusts the screen trace to a stationary pattern. Since the proper synchronization level is automatically maintained, the front panel contains no synchronization level control.

(4) AC SWITCH and INTENSITY

This control turns the unit on and determines the brilliance of the screen trace through an adjustment of the cathode ray tube bias. The control should be adjusted for an easily visible trace. In the absence of a vertical and a horizontal deflection voltage, the INTENSITY control should be adjusted so that the spot is not visible. A bright stationary spot may burn the screen.

(5) FOCUS

This control regulates the potential between the first and second anode of the cathode ray tube, thereby controlling the diameter of the electron beam. This regulates the sharpness of the screen trace.

(6) VERTical CENtering

This control determines the bias of one of the push-pull vertical amplifier stages. Thus, the trace can be adjusted up or down on the screen.

(7) HORizontal CENtering

This control determines the bias on one of the push-pull horizontal amplifier stages. Thus, the trace can be adjusted right or left on the screen.

b. Front Panel Receptacles

The receptacles on the front panel and their functions are as follows:

(1) EXTernal CAPacitor

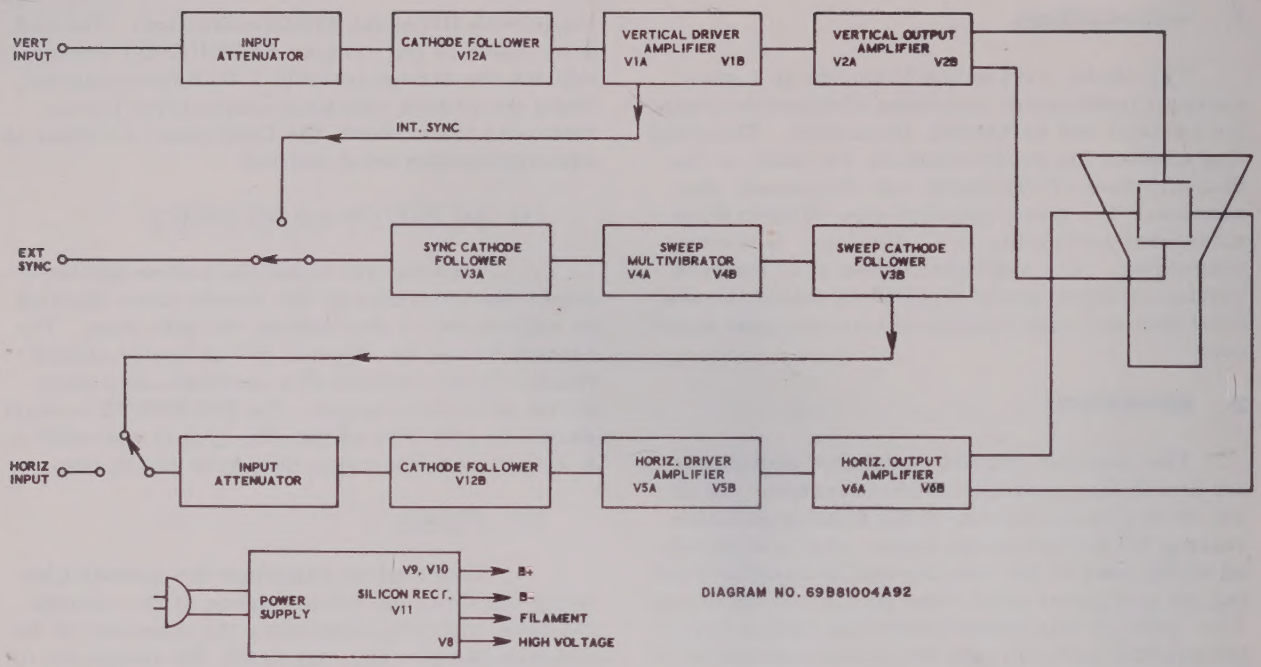
This receptacle permits an EXTernal CAPacitor to be connected to the sweep circuit for sweep FREQUENCY rates below 5 cps.

(2) EXTernal SYNChronization

This receptacle permits the application of an EXTernal SYNChronizing signal to lock the sweep generator.

(3) VERTical INput

This receptacle together with its ground




69B81004A92-O

Figure 1
Block Diagram

receives the signal applied to the vertical deflection amplifier.

(4) HORizontal INput

This receptacle together with its ground receives the signal applied to the horizontal deflection amplifier

## 3. CIRCUIT DESCRIPTION

To follow the circuit description in detail, see both figure 1 and the schematic diagram 63D81004A91.

a. Amplifier Circuit

Since the vertical and horizontal amplifier circuits are identical, only the vertical circuit will be discussed.

A signal applied to the VERTical INput terminals is coupled to the grid of V12A via the frequency compensated attenuator network. Capacitor C1 acts as a blocking capacitor in the a-c positions of the VERTICAL switch.

Tube V12A is an input cathode follower; a zero d-c reference is established in the V12A cathode circuit by adjusting the vertical balance control. The signal from V12A is coupled through vertical gain control R8 to V1A and V1B, the push-pull driver stage. (Common cathode coupling is used to apply the signal from V1A to V1B.) From V1A and V1B the signal is routed, via parasitic suppressors R16 and R18, to push-pull output stage V2A and V2B. Here the signal is again amplified and is applied to the vertical plates of the cathode ray tube, where it provides balanced deflection of the electron beam.

Simultaneously, the push-pull output of the horizontal amplifier is applied to the horizontal plates of the cathode ray tube, creating a complete pattern on the cathode ray tube face.

Vertical centering is accomplished by adjusting control R13 which changes the bias at the grid of V1A. The effect of this change is coupled through the push-pull driver and output stages to the cathode ray tube.

b. Sweep Generator

The horizontal sweep waveform is created by V4A and V4B, the sweep multivibrator. The sweep timing capacitor that is switched into the cathode circuit of V4B and the position of the fine

FREQUENCY control determine the horizontal frequency. The horizontal sweep waveform is made linear, in the form of a sawtooth, by the circuit of V3B and the neon lamp. The sweep position control is adjusted to provide the proper voltage reference at the center of the sawtooth waveform.

V3A, the sync cathode follower, receives either an EXTernal SYNChronizing signal from the binding post or an INTernal SYNChronizing signal from the vertical amplifier. The synchronizing signal is applied to the sweep multivibrator.

If the linear output of the sweep generator is not desired for a special application, a signal of any shape may be applied to the HORizontal INput terminals. This external signal will then be amplified in the horizontal channel and applied to the horizontal plates of the cathode ray tube.

c. Power Supplies

The fused power transformer feeds the Power Supply. The full-wave B+ supply contains V10, V9 and four filter capacitor sections. The half-wave B- supply contains the silicon diode rectifier, V11, and three filter capacitor sections. Tube V8, with the high voltage filter and the bleeder network, supply operating voltages for the cathode ray tube.

## 4. PRE-OPERATIONAL ADJUSTMENTS

a. Preliminary Adjustments

Figure 2 shows tube and adjustment control locations.

Set the controls and switches as follows:

VERTICAL and HORIZONTAL gain controls ..... Minimum

VERTICAL and HORIZONTAL attenuator switches..... AC, X100

FREQUENCY switch..... HORizontal INput

Fine FREQUENCY control..... Full counterclockwise

All other controls and adjustments ..... Middle of range

Plug the unit into a source of 105-125 volt, 50/60 cycles a-c only, and allow 5 minutes for warmup. Note that when power is applied to the unit, the voltage regulator tubes (V9 and V11) should glow with a purplish or orange light inside the tube elements. This is a normal condition. Also, the pilot light will normally not light for 10 to 15 seconds. During this warmup time, advance the INTENSITY control full clockwise and carefully adjust the centering controls until a spot appears on the tube face. If difficulty is encountered in centering the spot, connect a voltmeter between the chassis and 12BH7 plates (V6 and V2). When the d-c voltage reading is the same on both plates (adjust with centering control) the spot will be centered.

b. Astigmatism Control

As soon as the spot has been located, position it in the center of the tube face, and reduce the INTENSITY control until it is just visible. Carefully adjust the FOCUS and astigmatism controls in conjunction with each other to obtain the smallest possible spot. The astigmatism control is located on the rear panel bracket.

c. Vertical DC Balance

Turn the VERTICAL gain control (red knob) slowly clockwise and see if it moves the spot. If it does, return the spot to the original location with the vertical d-c balance control. Rotate the VERTICAL gain control from minimum to maximum a few times to be sure no further change in spot position occurs.

d. Horizontal DC Balance

Now turn the HORIZONTAL gain control (red knob) clockwise and see if the spot moves horizontally. If it does, return the spot to its original location with the horizontal d-c balance control. Turn the HORIZONTAL gain control back and forth a few times, as in the previous step, to be sure no further change in spot position occurs.

e. Sweep Positioning Control

Set the FREQUENCY switch to the 50 position. Slowly advance the HORIZONTAL gain control (red knob) and observe the trace. It will probably shift to one side as it becomes a short line. Slowly adjust the sweep positioning control. When this is properly adjusted, advancing the HORIZONTAL gain control should expand the dot, at the same speed, in both directions.

Now switch the HORIZONTAL Attenuator to a-c X10 position, and check the adjustment. This

line will be much longer and the adjustment more critical. Slightly readjust the sweep positioning control if necessary.

## 5. OPERATION

a. General Considerations

This unit, like most electronic equipment, generates a certain amount of heat. Be sure the ventilation openings of the cabinet are not obstructed in any way. It is entirely normal for the outside of the cabinet to become quite warm after a few minutes of operation.

Although the cathode ray tube is shielded to prevent trace distortion due to magnetic fields, it is possible that some trace distortion due to a very high field may still occur. The shield will certainly reduce these effects, but may not entirely eliminate them. If this appears to be a problem, the simplest remedy is to find a location for the scope farther from the offending equipment.

b. Vertical and Horizontal Amplifiers

To prevent overloading the input stages in the amplifier, always reduce a large amplitude signal with the attenuator switch and not the variable gain control. Try to keep the variable gain control setting as high as possible to avoid this difficulty.

When using d-c coupling on either or both amplifiers, remember that it may not be possible to see a small signal superimposed on a high d-c voltage. This is entirely normal and will be better understood if you remember that the d-c component of the signal will be amplified by the same amount as the signal voltage. A shift in centering will also result with changes in gain and/or attenuator settings. This, too, is normal as these controls affect the gain of the amplifier.

c. Sweep Generator

In the INTernal SYNChronization positions of the FREQUENCY control, a portion of the input signal is taken from the vertical amplifier and applied to the sweep multivibrator. This is done to hold the sweep generator at the same frequency or at a submultiple of the input signal

In the EXTernal SYNChronization positions, a portion of the input signal may be applied directly to the EXT SYNC binding post, allowing external control for more or less synchronization signal.

d. Fine FREQUENCY Control

After the correct sweep frequency range has been selected, only the fine FREQUENCY control has to be adjusted to obtain a stable pattern. Form the habit of setting the fine FREQUENCY control with a small vertical signal (1-2 squares high). This will assure best performance of the synchronization circuit during changing signal conditions.

## 6. APPLICATIONS

This oscilloscope is a very versatile instrument. Properly used, there is almost no limit to the number and type of measurements it can provide. To actually list the wide variety of applications in which your T1015A Oscilloscope may be used is beyond the scope of this manual. However, several common applications are listed below:

- Checking the output voltage and frequency of an oscillator circuit
- Used with a monitor for measuring frequency deviation
- Checking for distortion
- Checking tone-operated equipment such as "Private-Line" radios, "Quik-Call" equipment, etc.
- Checking the frequency response of an amplifier
- Troubleshooting two-way radio audio amplifier stages, closed-circuit TV
- Used with a computer as a read-out device
- Measuring d-c voltage

## 7. MAINTENANCE

This instrument should be serviced by personnel qualified in maintaining laboratory test equipment. It is an accurate, sensitive instrument and should be treated as such. When qualified personnel or adequate equipment are not available, the instrument should be returned to the factory for service or calibration.

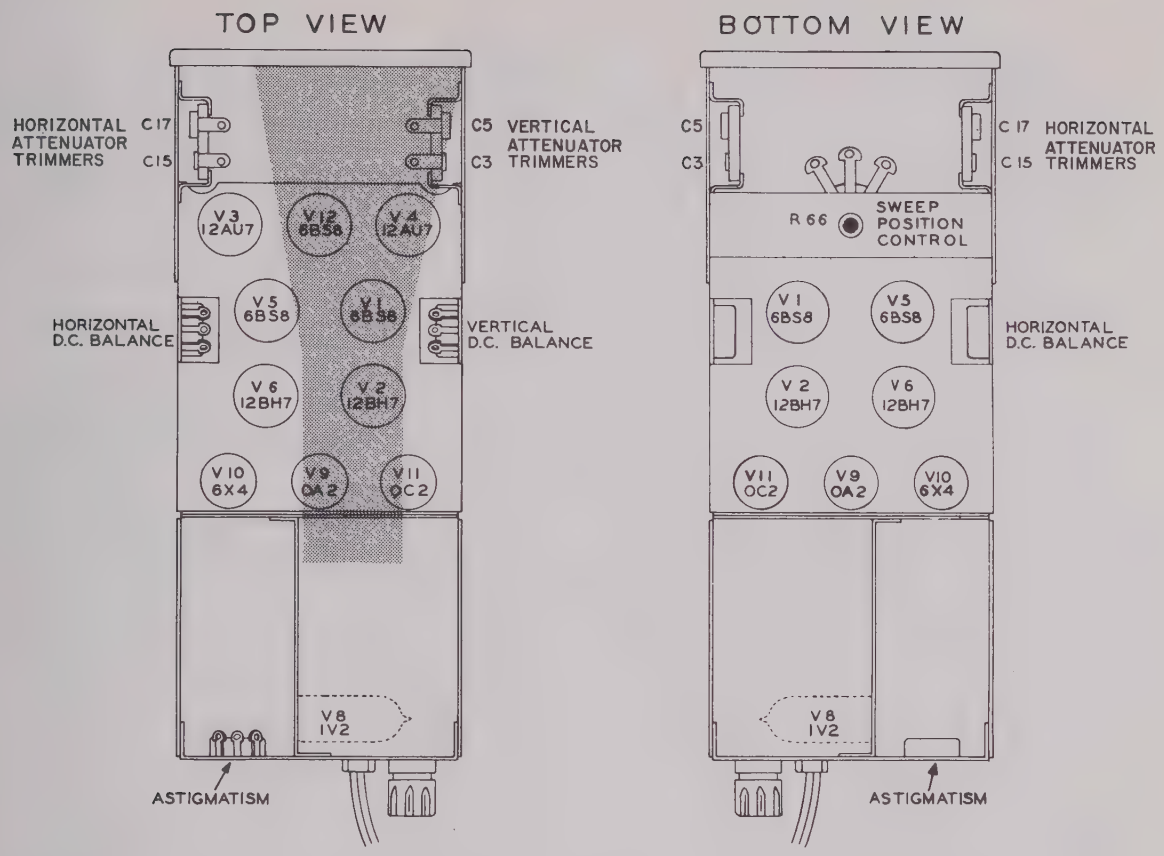



Figure 2
Tubes and Adjustment Controls

a. Service Accessibility

Unscrew the two rear 6-32 5/8" binder head screws. Gently slip the unit out of the cabinet. The internal circuitry will now be exposed. Refer to schematic diagram 63D81004A91 for tube complement and wiring connections. Refer to figure 2 for tube locations.

b. Cathode Ray Tube Positioning

If the trace is not perfectly horizontal, correct the condition as follows:

***CAUTION***

High voltage is applied to the cathode ray tube. Under NO circumstances attempt to rotate the tube with the power applied to the unit.

Observe the position of the trace on the cathode ray tube and estimate how far the tube should be turned. Turn off the power and pull the plug. Loosen the clamp at the neck of the cathode ray tube and rotate the tube the proper amount by turning its socket. Do not allow the tube to slide forward and come into contact with the grid screen. If the cathode ray tube is tightly fitted in the shield, it may be necessary to swing the rear panel back and/or remove V8, the 1V2 tube. This process may be repeated if the trace is still slightly tilted. Now, carefully tighten the cathode ray tube neck clamp to hold the tube in place. Be sure not to overtighten and break the tube neck. Turn the unit on again and check to be sure the trace is horizontal.

c. HORIZONTAL Attenuator Compensation

Place both the VERTICAL and HORIZONTAL gain controls in the full counterclockwise position and readjust the centering controls (if necessary) to position the beam in the center of the screen. Set the FREQUENCY switch to the IN-

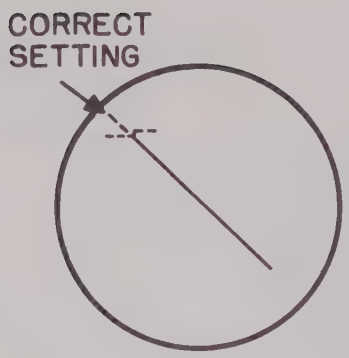



Figure 3
Trace on Screen

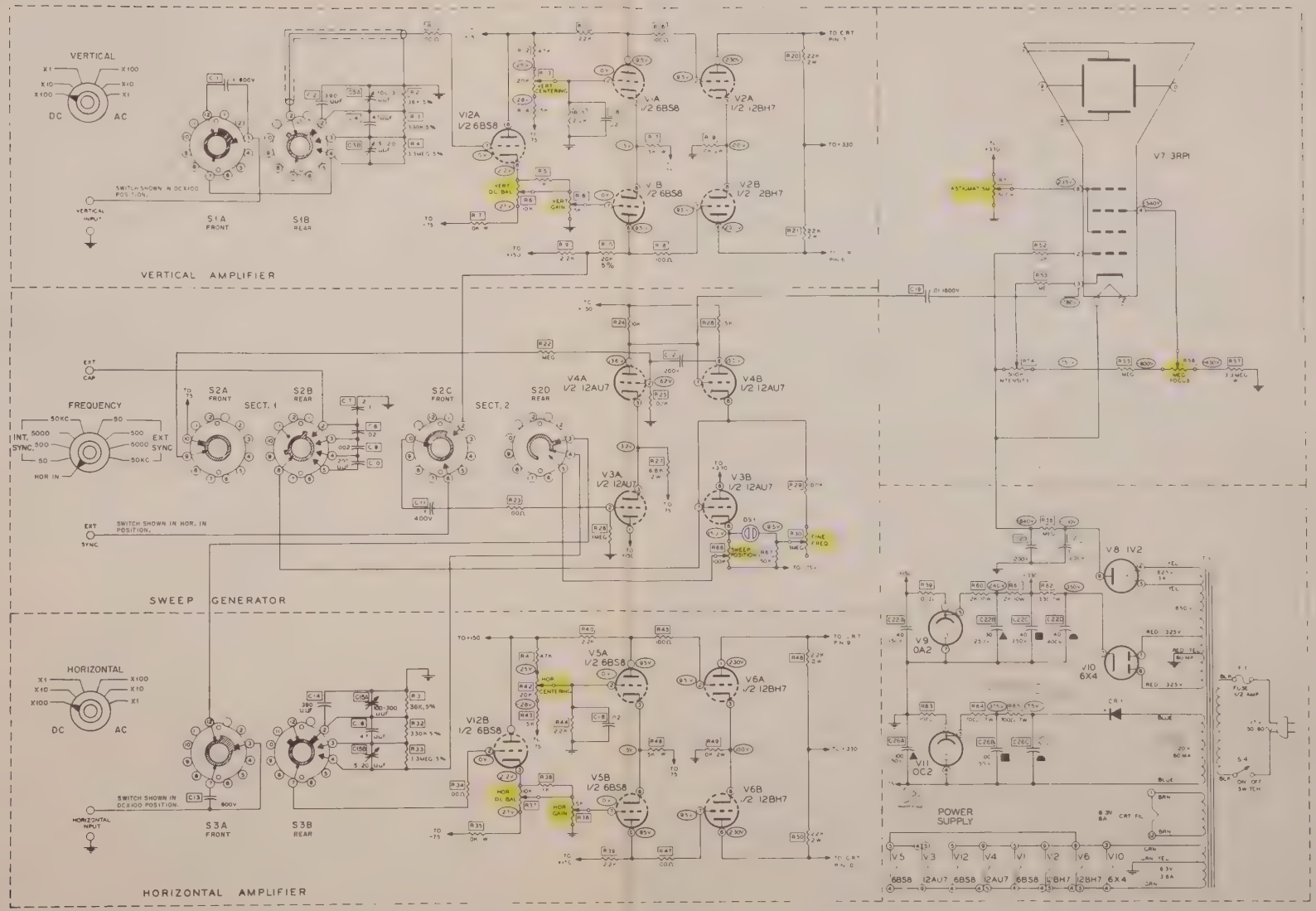
Ternal SYNC 5000 position and the fine FREQUENCY control to the center of its range. Set the VERTICAL attenuator switch to the AC X1 position, and the HORIZONTAL attenuator switch to the AC X10 position. Turn the unit off and connect a lead between the red VERTical INput binding post and the center lug of the sweep positioning control. Turn the unit on, and after warmup adjust the VERTICAL and HORIZONTAL gain controls until a trace similar to figure 3 appears. Adjust the horizontal attenuator trimmer capacitor nearest the front panel to provide the straightest line. Now set the HORIZONTAL attenuator switch to the AC X100 position and readjust the gain controls to provide a trace similar to figure 3 as before. This time adjust the horizontal attenuator trimmer farthest from the front panel to provide the straightest line.

d. VERTICAL Attenuator Compensation

Place the gain controls to the counterclockwise position and set the HORIZONTAL attenuator switch to the AC X1 position. Set the VERTICAL attenuator switch to the AC X10 position. Adjust the gain controls until a trace similar to figure 3 appears. Adjust the vertical attenuator trimmer capacitor nearest the front panel to provide the straightest line. Now set the VERTICAL attenuator switch to the AC X100 position and readjust the gain controls to provide a trace similar to figure 3. This time adjust the vertical attenuator farthest from the front panel. Now remove the lead.

e. Troubleshooting Chart

| TROUBLE | SUGGESTED TEST |
|---|---|
| Tube filaments do not light | Check fuse - check filament voltage. |
| No spot or trace | Remove vertical output tubes, if spot appears check vertical circuit voltage and tubes.<br>Remove horizontal output tubes - if spot appears check horizontal circuit voltage and tubes.<br>Check for high voltage. |
| No vertical deflection | Check vertical tubes and voltages. |
| No horizontal sweep | Check horizontal tubes and voltages. |
| A tube filament does not light | Check tube. |
| No B+ | Check fuse.<br>Check V9 and V10.<br>Check for open resistors, shorted capacitors or defective tubes. |
| No B- | Check fuse.<br>Check silicon rectifier and V11.<br>Check for open resistors or shorted capacitors. |
| Poor focusing | Check V8 - check high voltage bleeder resistors R54, R55, R56 and R57.<br>Check C19. |




NOTES

1. SWITCHES ARE VIEWED FROM THE FRONT
2. ALL RESISTORS ARE 1/2 WATT UNLESS SHOWN OTHERWISE
3. ALL RESISTOR VALUES ARE IN OHMS K = 1000 OHMS MEG = 1 000 000 OHMS
4. ALL CAPACITOR VALUES ARE IN μf UNLESS OTHERWISE SHOWN
5. ALL VOLTAGES ARE FROM POINT INDICATED TO CHASSIS GROUND EXCEPT AC VOLTAGES ON POWER TRANSFORMER WINDINGS. DC READINGS WERE TAKEN WITH A MOTOROLA MODEL S1052A OC MULTIMETER.

T1051A General Purpose Oscilloscope
Schematic Diagram
Motorola No. 63D81004A91-O

PARTS LIST for Schematic Diagram 63D81004A91-O

T1015A Oscilloscope

| REFERENCE SYMBOL | MOTOROLA PART No. | DESCRIPTION |
|---|---|---|
| | | CAPACITOR, fixed: uf; unless stated; |
| C1, 13 | 8A83850 | 0.1; 600 v |
| C2, 14 | 21K859945 | 390 uuf |
| C3, 15 | 20P82017D18 | var; dual; c/o; |
| C3A, 15A | | 100-300 uuf |
| C3B, 15B | | 5-20 uuf |
| C4, 16 | 21K841965 | 47 uuf |
| C6, 8, 18 | 21K401029 | .02 |
| C7 | 8P82017D15 | 0.2 |
| C9 | 21K837746 | .002 |
| C10 | 21P82017D12 | 200 uuf |
| C11 | 8K858370 | 1; 400 v |
| C12 | 8K483026 | 0.1; 200 v |
| C19 | 21P82017D13 | .01; 1600 v |
| C20, 21 | 8P82017D14 | 0.1; 1200 v |
| C22 | 23P82017D17 | 4 section; c/o; |
| C22A | | 40; 150 v |
| C22B | | △ 30; 250 v |
| C22C | | □ 40; 350 v |
| C22D | | ⌓ 40; 400 v |
| C26 | 23P82017D16 | 3 section; c/o; |
| C26A | | △ 100; 150 v |
| C26B | | □ 100; 150 v |
| C26C | | ⌓ 100; 150 v |
| | | SEMICONDUCTOR DEVICE, diode: (SEE NOTE) |
| CR1 | 48P82017D20 | silicon |
| | | LAMP, neon: |
| DS1 | 65P82017D24 | special |
| | | FUSE, cartridge: |
| F1 | 65R890033 | 1-1/2 amp; 250 v |
| | | RESISTOR, fixed: ±10%; 1/2 w; unless stated; |
| R1, 16, 18, 23, 34, 45, 47, 59, 63 | 6R6326 | 100 |
| R2, 31 | 06S125A86 | 36K ±5% |
| R3, 32 | 6R400067 | 330K ±5% |
| R4, 33 | 6R488185 | 3.3 meg ±5% |
| R5, 36 | 6R6229 | 1K |
| R6, 37 | 18P82017D06 | var; 10K |
| R7, 35 | 6R6430 | 10K; 1 w |
| R8, 38 | 18P82017D11 | var; 5K; incl. ref. part S1, S3 |
| R9, 15, 44 | 6R6069 | 2.2K |
| R10 | 6R5785 | 20K ±5% |
| R11, 39, 40 | 6R6397 | 22K |
| R12, 41 | 6R6048 | 47K |
| R13, 42 | 18P82017D04 | var; 20K |
| R14, 28, 43 | 6R6477 | 15K |
| R17, 46 | 6R6431 | 15K; 1 w |
| R19, 49 | 6R6299 | 10K; 2 w |
| R20, 21, 48, 50 | 6R2098 | 22K; 2 w |
| R22, 26, 53, 55, 58 | 6R6046 | 1 meg. |
| R24 | 6R6320 | 10K |
| R25, 29, 52 | 6R6031 | 100K |
| R27 | 6R5691 | 6.8K; 2 w |
| R30 | 18P82017D10 | var; 3 meg; incl. ref. part S2 |
| R51 | 18P82017D08 | var; 500K |
| R54 | 18P82017D09 | var; 500K; incl. ref. part S4 "ON-OFF" switch |
| R56 | 18P82017D05 | var; 1 meg. |
| R57 | 6R488032 | 3.3 meg; 1 w |
| R60, 61 | 17P82017D03 | 2K; 10 w |
| R62 | 17P82017D01 | 330; 7 w |
| R64, 65 | 17P82017D02 | 700; 7 w |
| R66 | 18P82017D07 | var; 100K |
| R67 | 6R6398 | 150K |
| | | SWITCH, |
| S1, 3 | | rotary; 2 section; p/o R8, R38 |
| S2 | | rotary; 4 section; p/o R30 |
| S4 | | spst; "ON-OFF"; p/o R54 |

| REFERENCE SYMBOL | MOTOROLA PART No. | DESCRIPTION |
|---|---|---|
| | | TRANSFORMER, power: c/o; |
| T1 | 25P82017D19 | pri: BLK, BLK<br>sec: #1; YEL, RED with taps YEL, RED, RED-YEL<br>sec: #2; BLU, BLU<br>sec: #3; BRN, BRN<br>sec: #4; GRN, GRN with GRN-YEL tap |
| | | TUBE, electron: |
| V1, 5, 12 | | type 6BS8 |
| V2, 6 | | type 12BH7 |
| V3, 4 | 195T133A02 | type 12AU7 |
| V7 | | type 3RP1 |
| V8 | 195T141A01 | type 1V2 |
| V9 | 195T204A01 | type OA2 |
| V10 | 195T105A01 | type 6X4 |
| V11 | 195T298A01 | type OC2 |
| | | SOCKET, tube: |
| XV1, 2, 3, 4, 5, 6, 8, 12 | 9P82017D26 | 9 contact |
| XV7 | 9P82017D27 | 12 contact |
| XV9, 10, 11 | 9P82017D25 | 7 contact |
| | | FUSEHOLDER, |
| XF1 | 9C82083C02 | single hole, panel mounting |
| | NON-REFERENCED ITEMS | |
| | 9P82017D28 | POST, binding: RED; 2 req'd |
| | 9P82017D29 | POST, binding: BLK; 4 req'd |
| | 36P82017D21 | KNOB, dual control: RED; front section; 3 req'd |
| | 36P82017D22 | KNOB, control: small; BLK; 4 req'd |
| | 36P82017D23 | KNOB, dual control: BLK; rear section; 3 req'd |

NOTE:

Replacement diodes must be ordered by Motorola part number only for optimum performance.

national

MOTOROLA

RADIO COMMUNICATIONS

service

MP MASTER

MA36352